

STEADY-STATE MEASUREMENT OF THERMAL CONDUCTIVITY OF CERAMICS AND CERAMIC COATINGS

Andrew J. Slifka

NIST, Materials Reliability Division
Boulder, Colorado 80305 USA

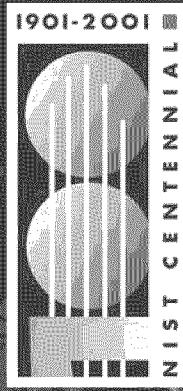
and

D.D. Hass and H.N.G. Wadley
Department of Materials Science
University of Virginia
Charlottesville, Virginia 22903 USA



National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

Thermal Materials Workshop 2001
Cambridge, UK
30 May to 1 June 2001



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

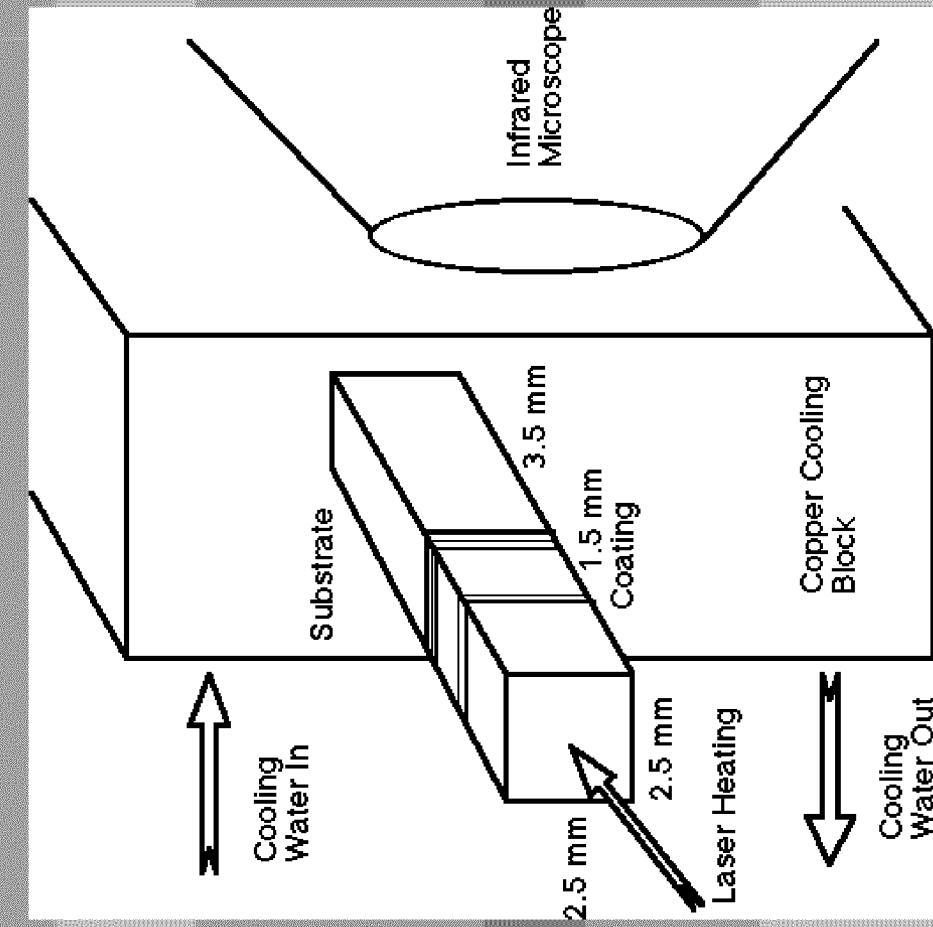
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE 30 May 2001	3. REPORT TYPE AND DATES COVERED Workshop Presentations, 30 May-1 June 2001	
4. TITLE AND SUBTITLE Steady-State Measurement of Thermal Conductivity of Ceramics and Ceramic Coatings		5. FUNDING NUMBERS	
6. AUTHOR(S) Slifka, Andrew J.; Hass, D. D.; Wadley, H. N.			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) NIST Materials Reliability Division Boulder, CO 80305		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Research International Field Office Washington, DC		10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES See Also ADM001348, Thermal Materials Workshop 2001, held in Cambridge, UK on May 30-June 1, 2001. Additional papers can be downloaded from: http://www-mech.eng.cam.ac.uk/onr/			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Distribution A: Approved for public release; distribution unlimited		12b. DISTRIBUTION CODE A	
13. ABSTRACT (Maximum 200 Words) Thermal Materials Workshop presentation.			
14. SUBJECT TERMS		15. NUMBER OF PAGES 19	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT Unlimited

Discussion Points

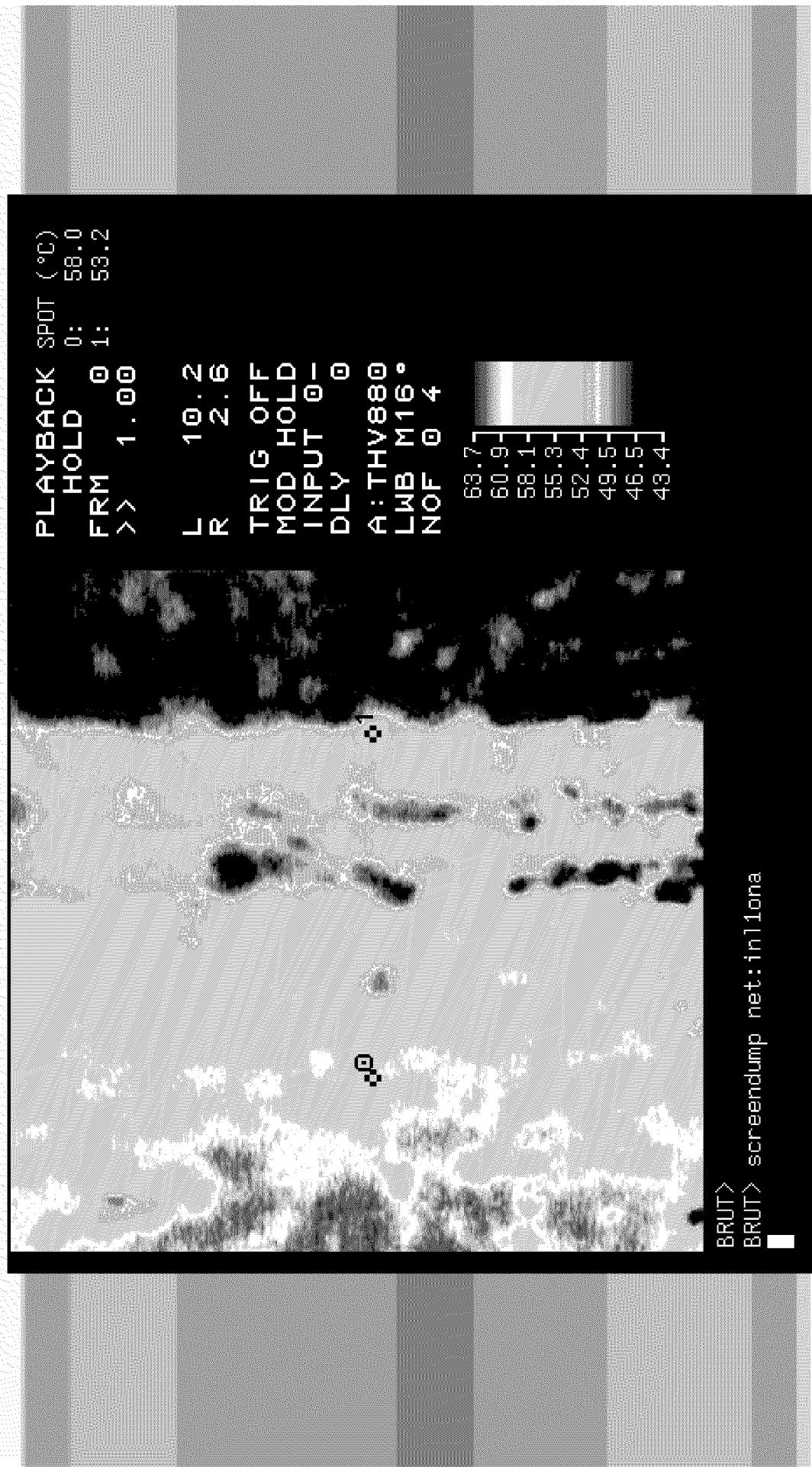
- Steady-State Measurement Method
- Validation
- EB-PVD \rightarrow EB-DVD
- Future Direction (SPM)

Measurement using Infrared Microscopy

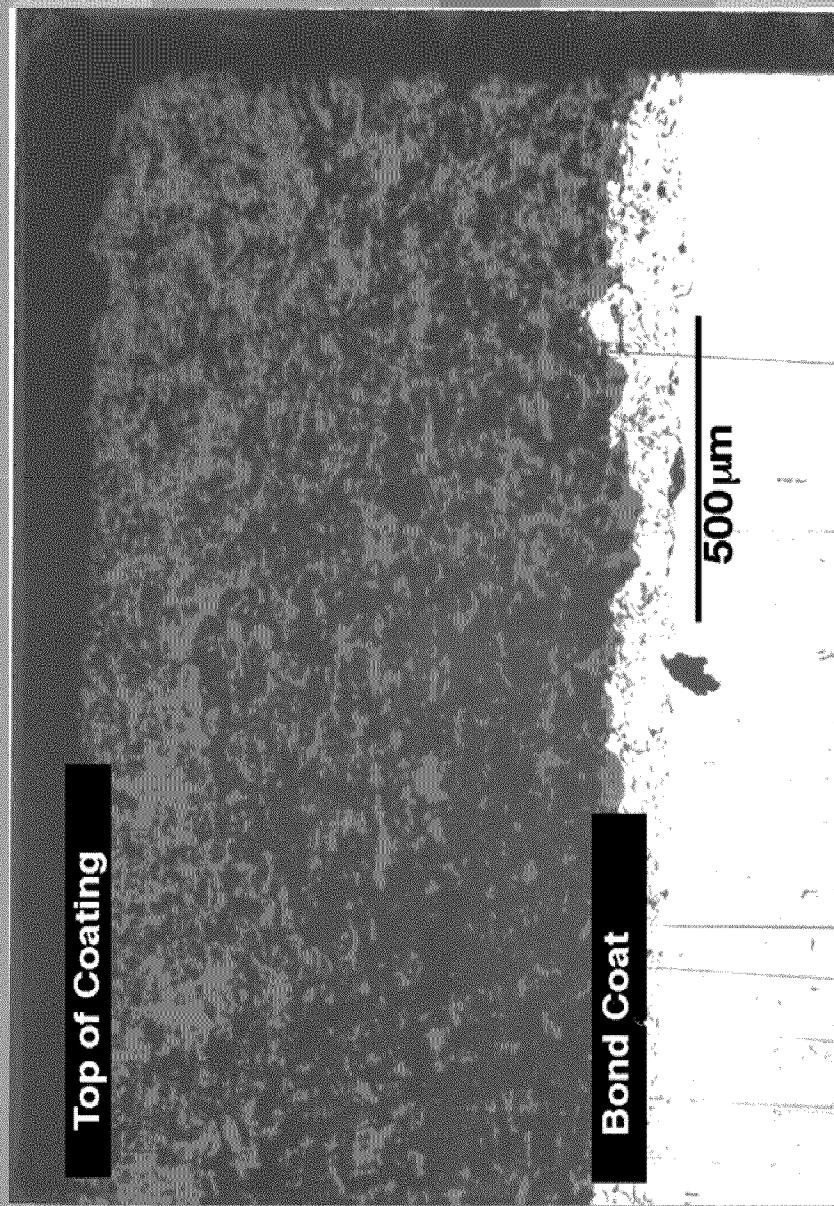
- 1.6 x 1.6 mm field-of-view
- 8 to 12 μm detection
- 10 μm spatial resolution
- Room temperature to 250 $^{\circ}\text{C}$
- Steady-state
- Laser or Joule heating



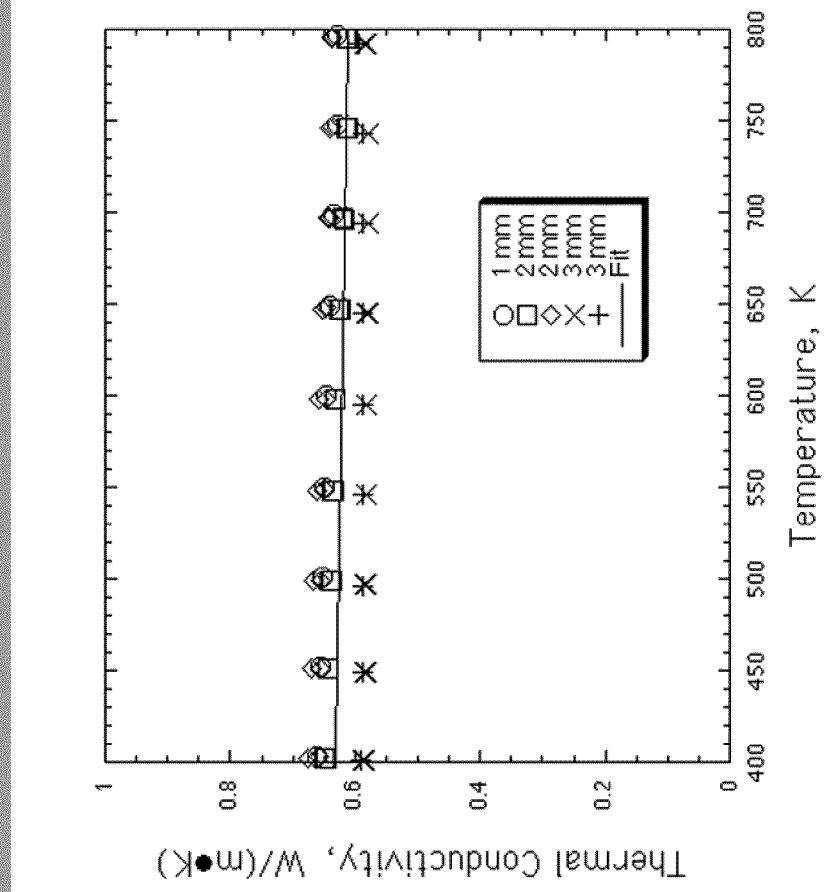
Infrared Micrograph of an Alumina-Nickel, 4-layer Functionally Graded Coating on a Nickel Substrate



Plasma-Sprayed 1.0 mm thick 8% Yttria-Stabilized Zirconia Coating with 0.1 mm thick NiCrAlY Bond Coat on 410 Stainless Steel

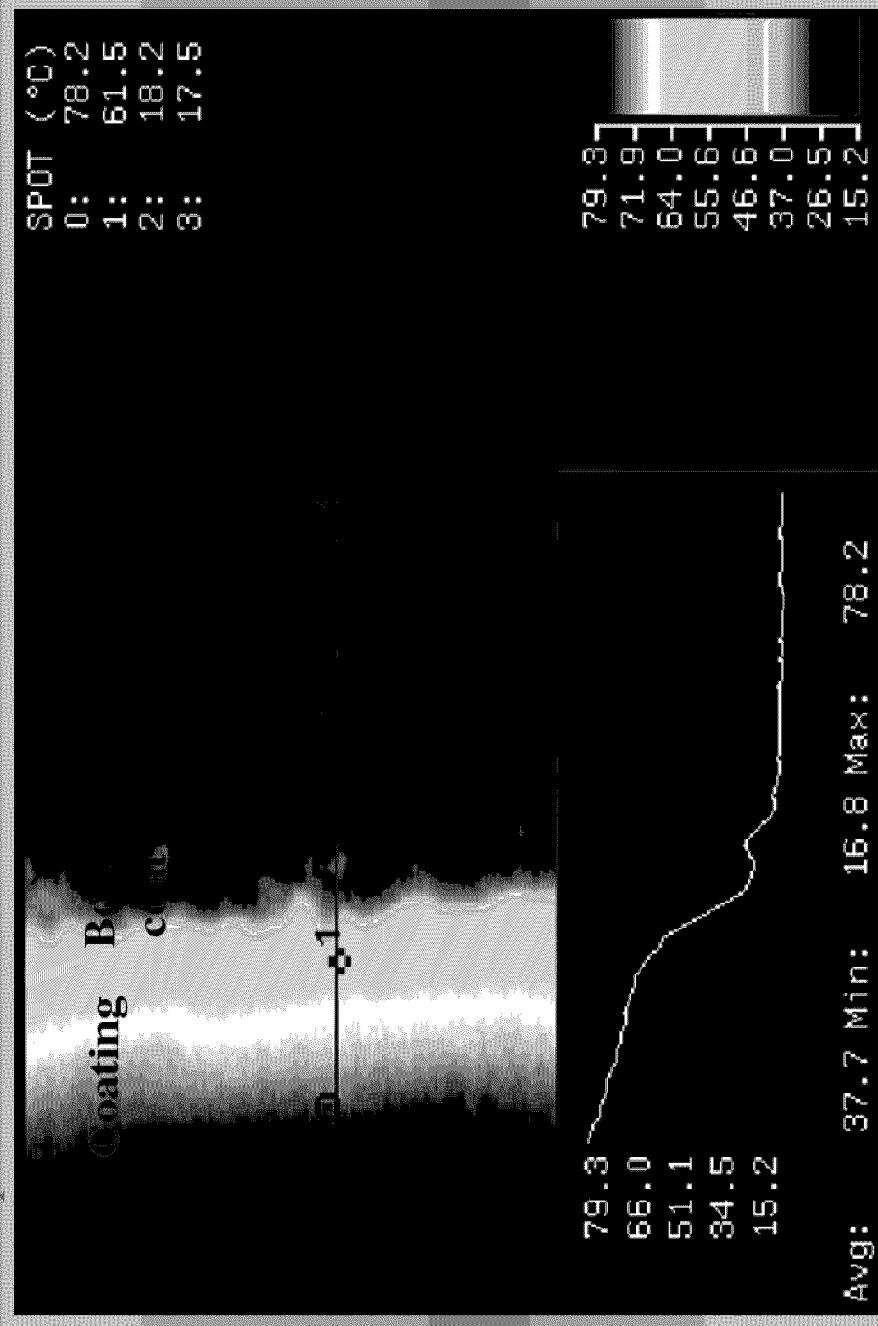


Results for an 8% Yttria-Stabilized-Zirconia Coating on 410 Stainless Steel

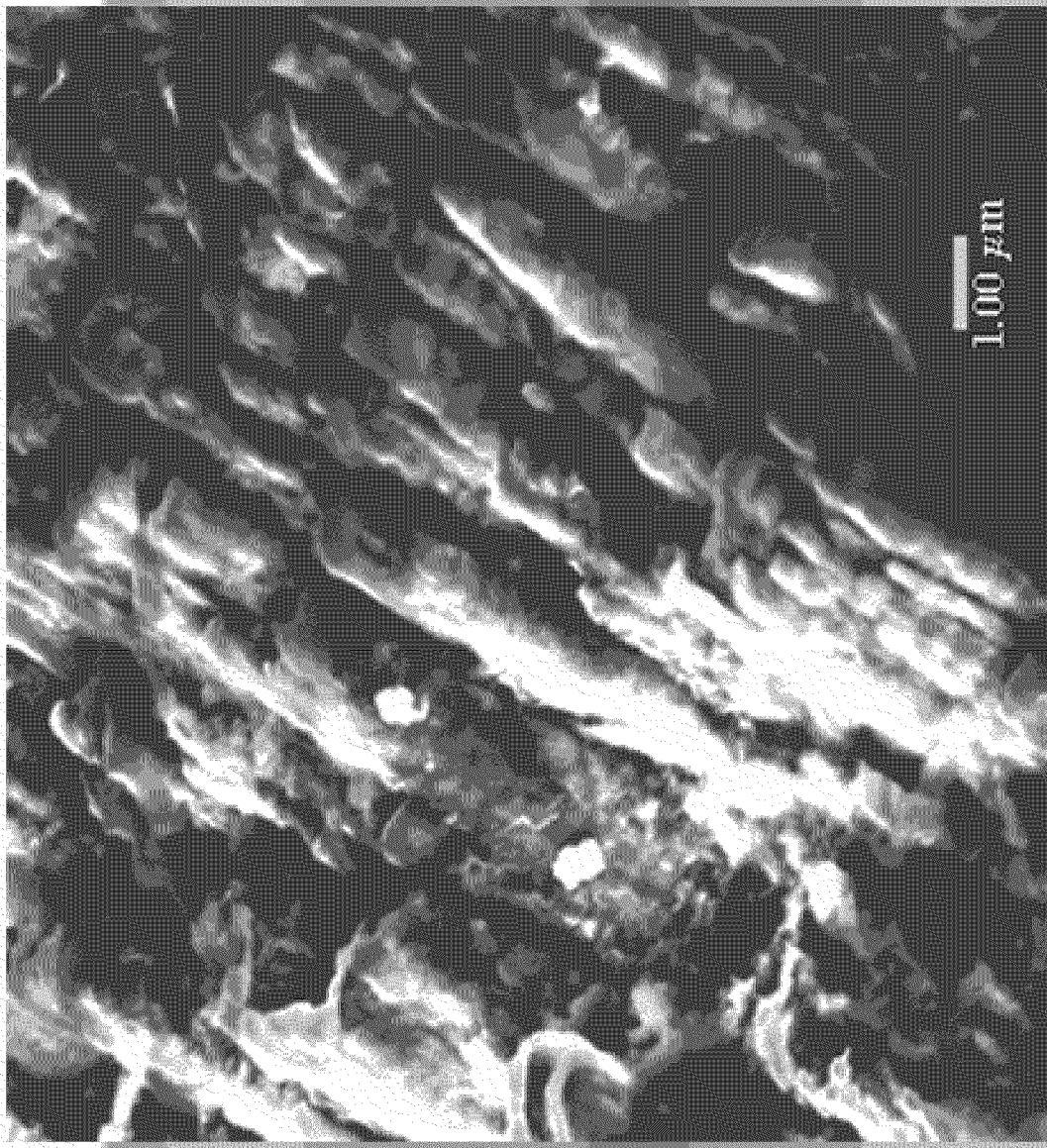


Infrared Microscope Image of a Plasma Sprayed 8% Yttria-Stabilized Zirconia Coating, 1.0 mm thick, on a 0.1 mm thick NiCrAlY Bond Coat on 410 SS

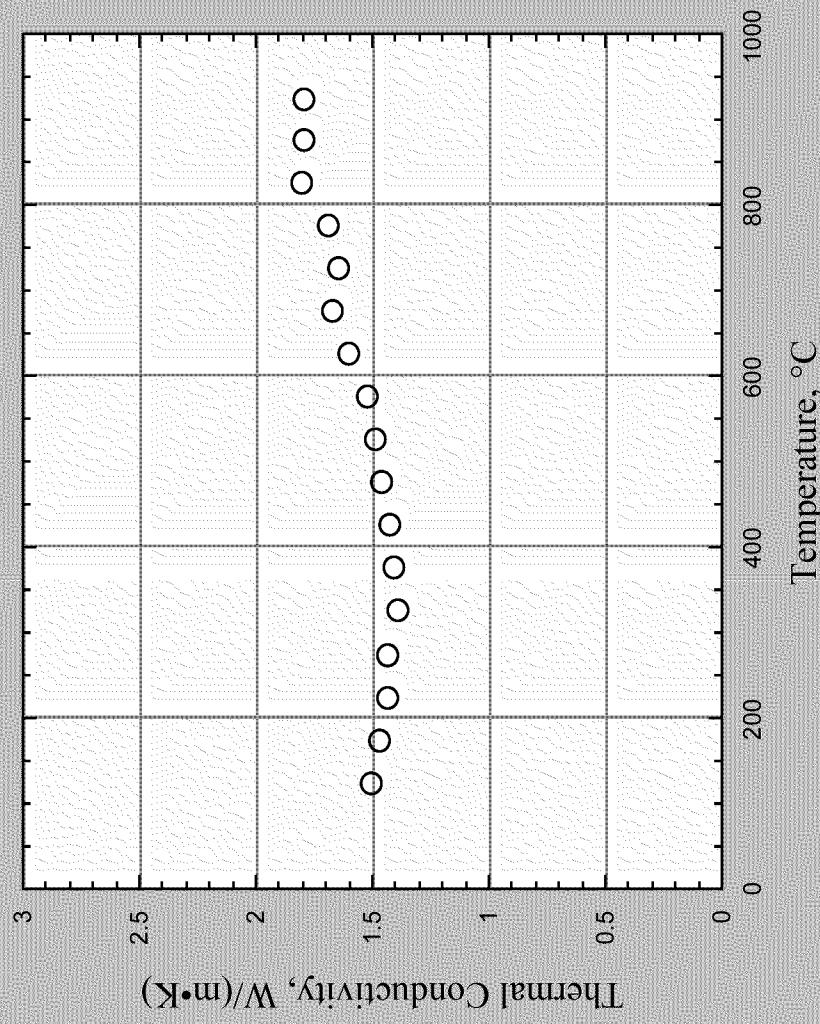
• Specific Interfacial Thermal Resistance 4.1 E-4 m²•K/W



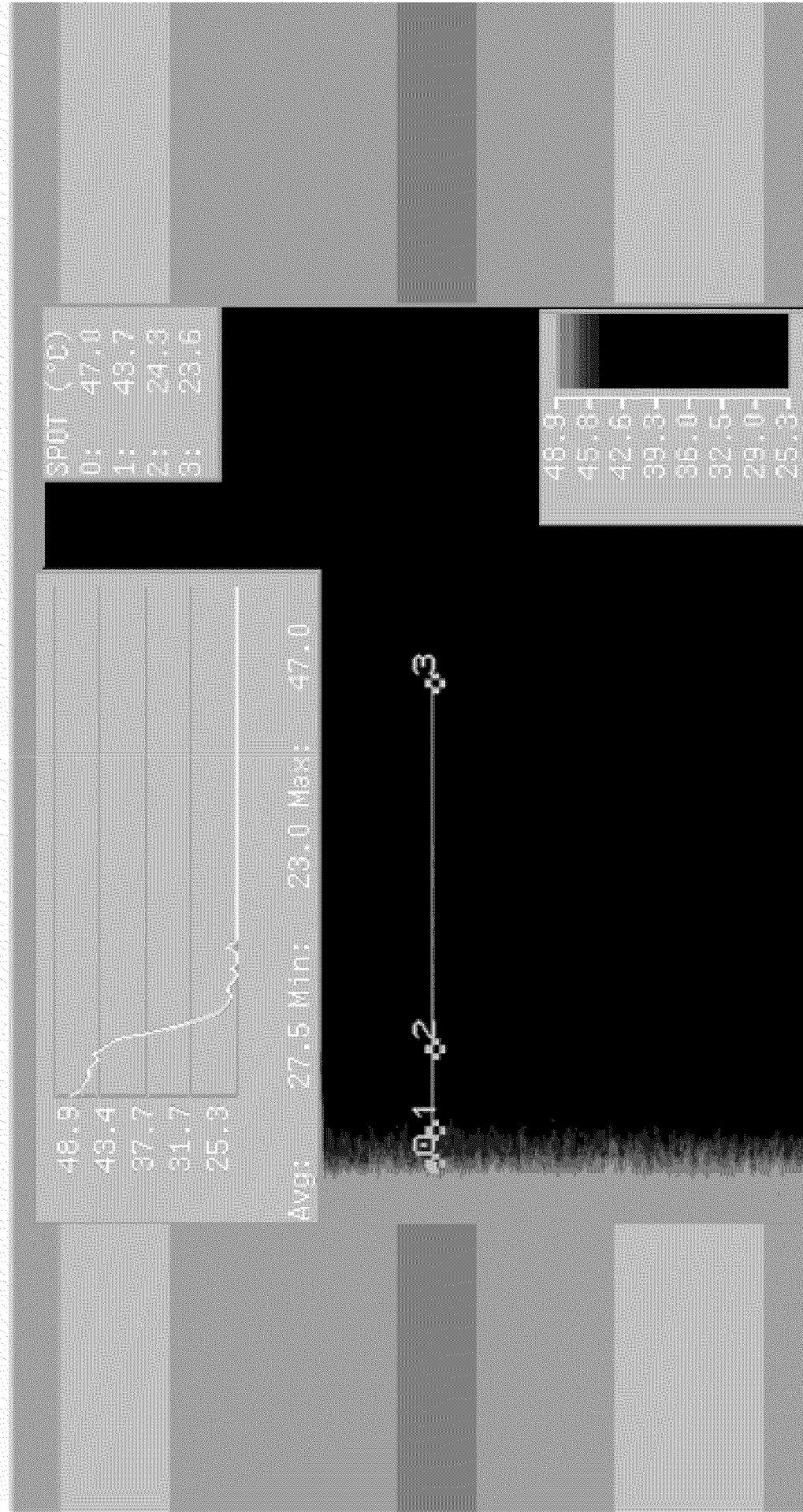
Microstructure of a 7% YSZ EB-PVD Coating



GHP Measurement of an EBPVD Coating from an Industrial Collaborator

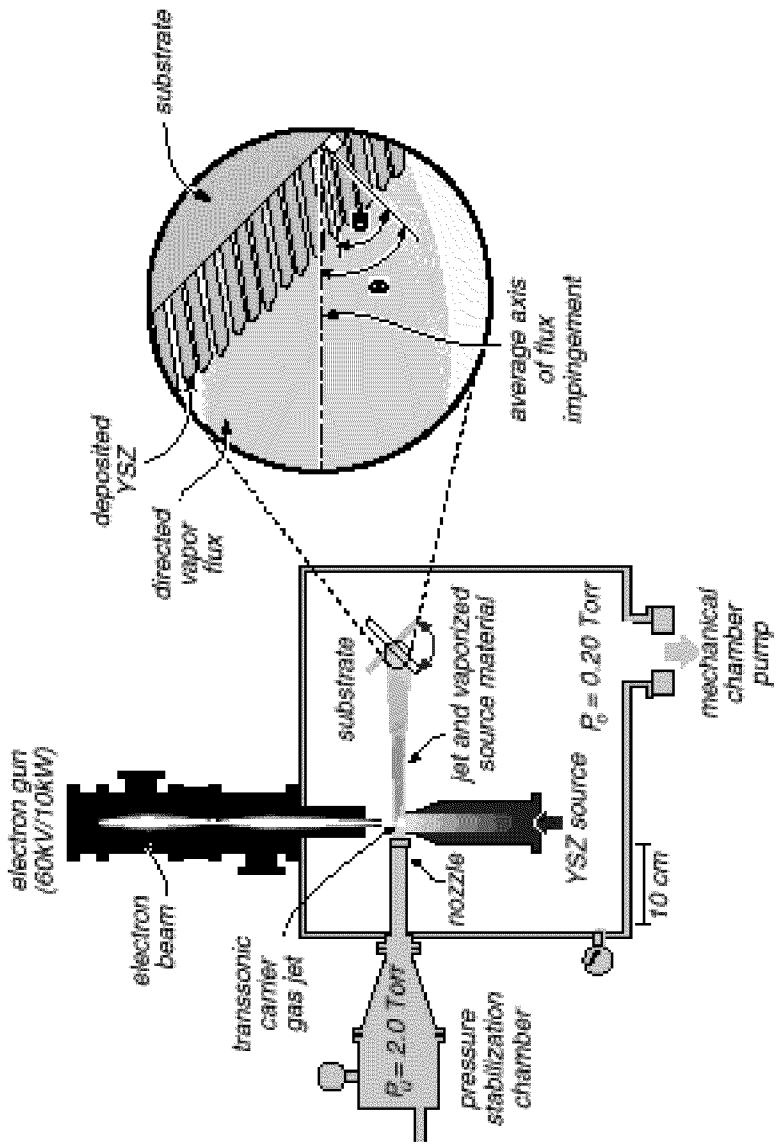


Infrared Image of an EBPVD Coating

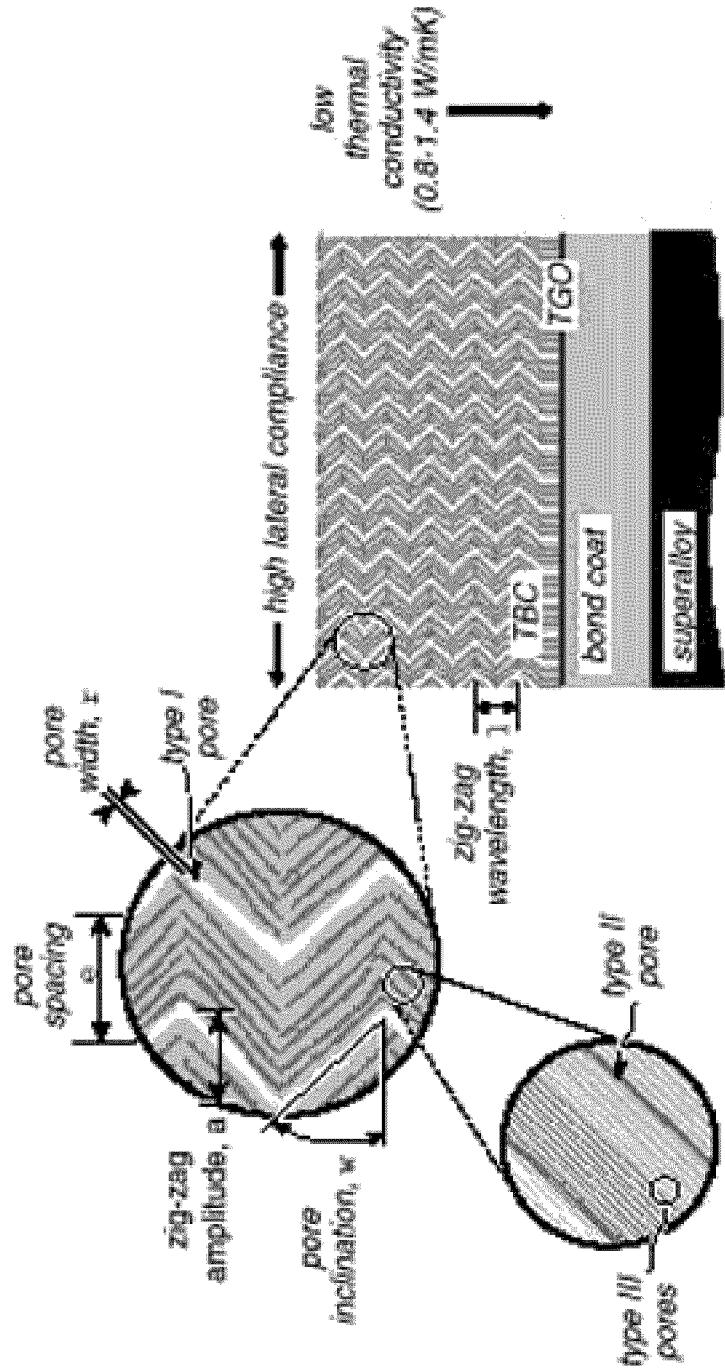


IR Microscopy of Coatings EB-DVD method

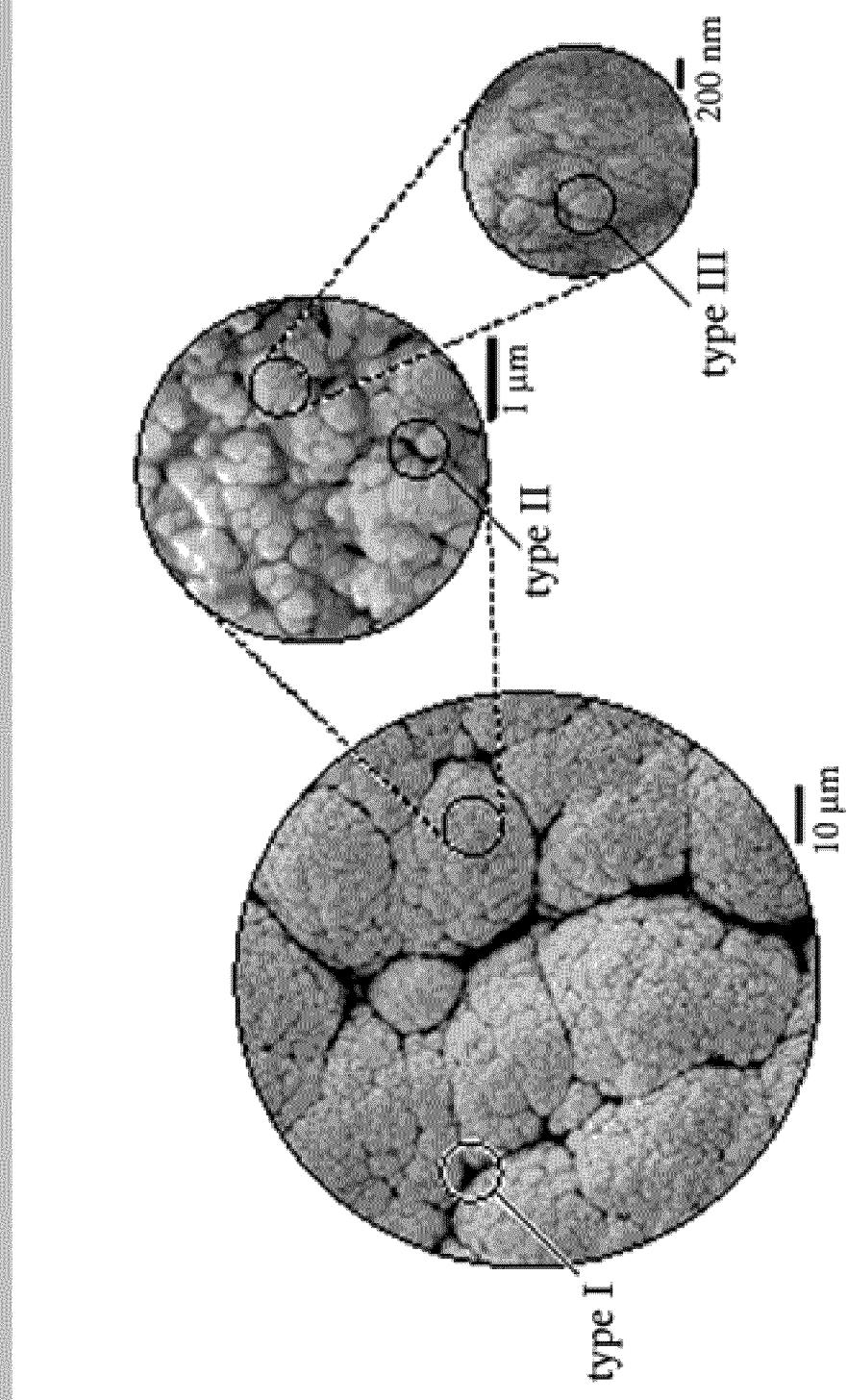
EB-DVD Processing Approach



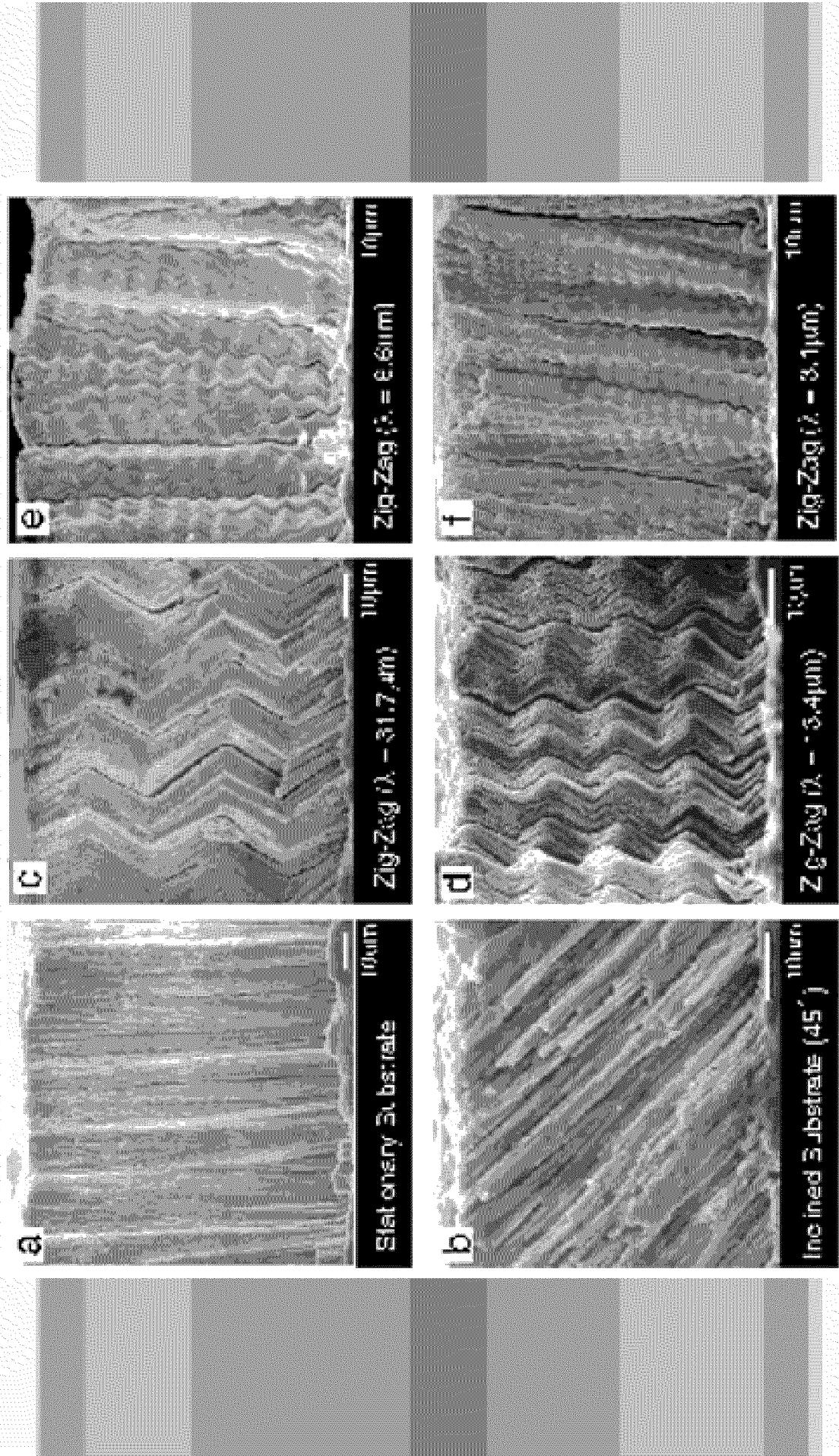
Zig-Zag Coatings



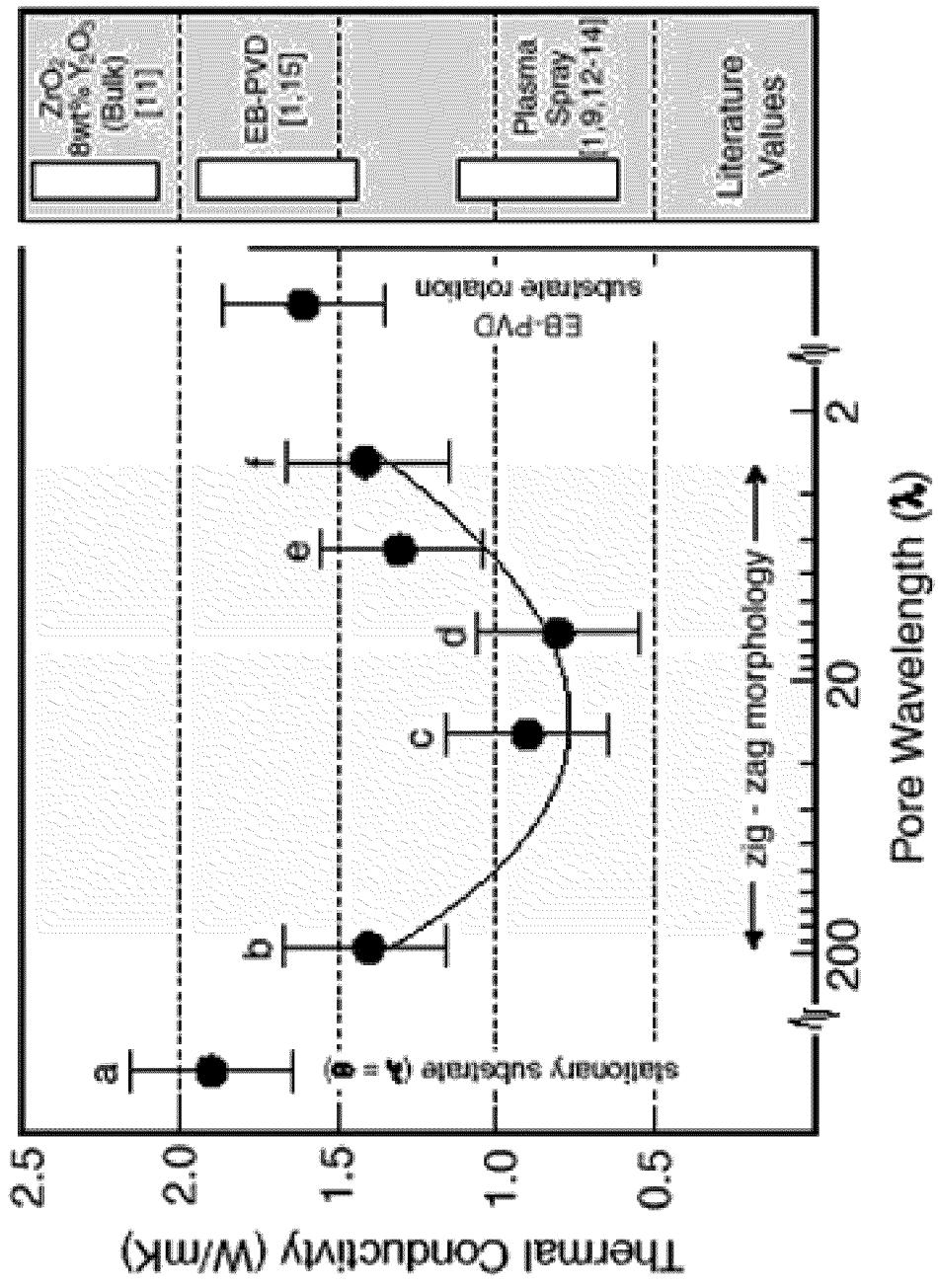
Pore Morphology



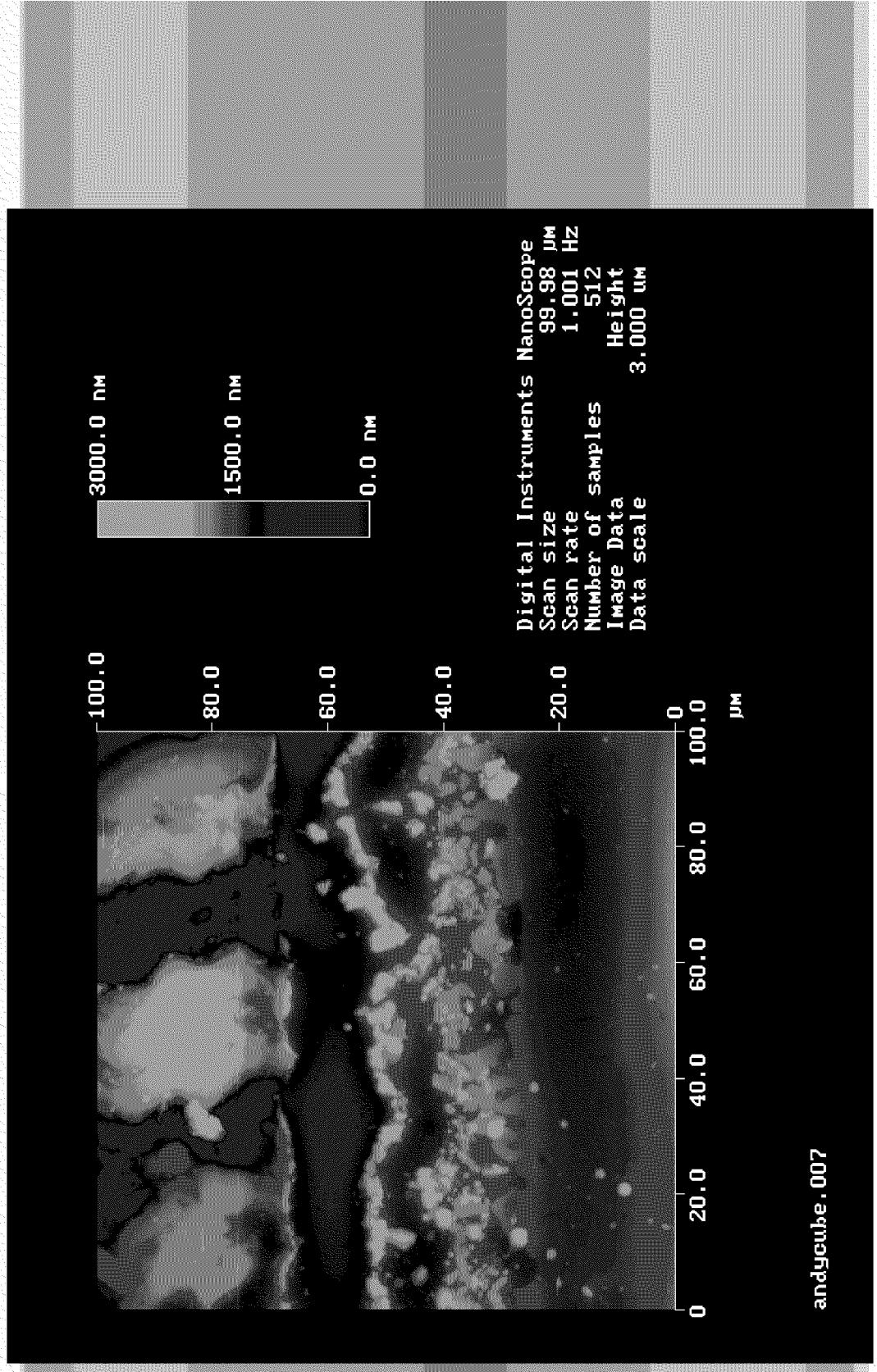
EB-DVD Coating Morphologies



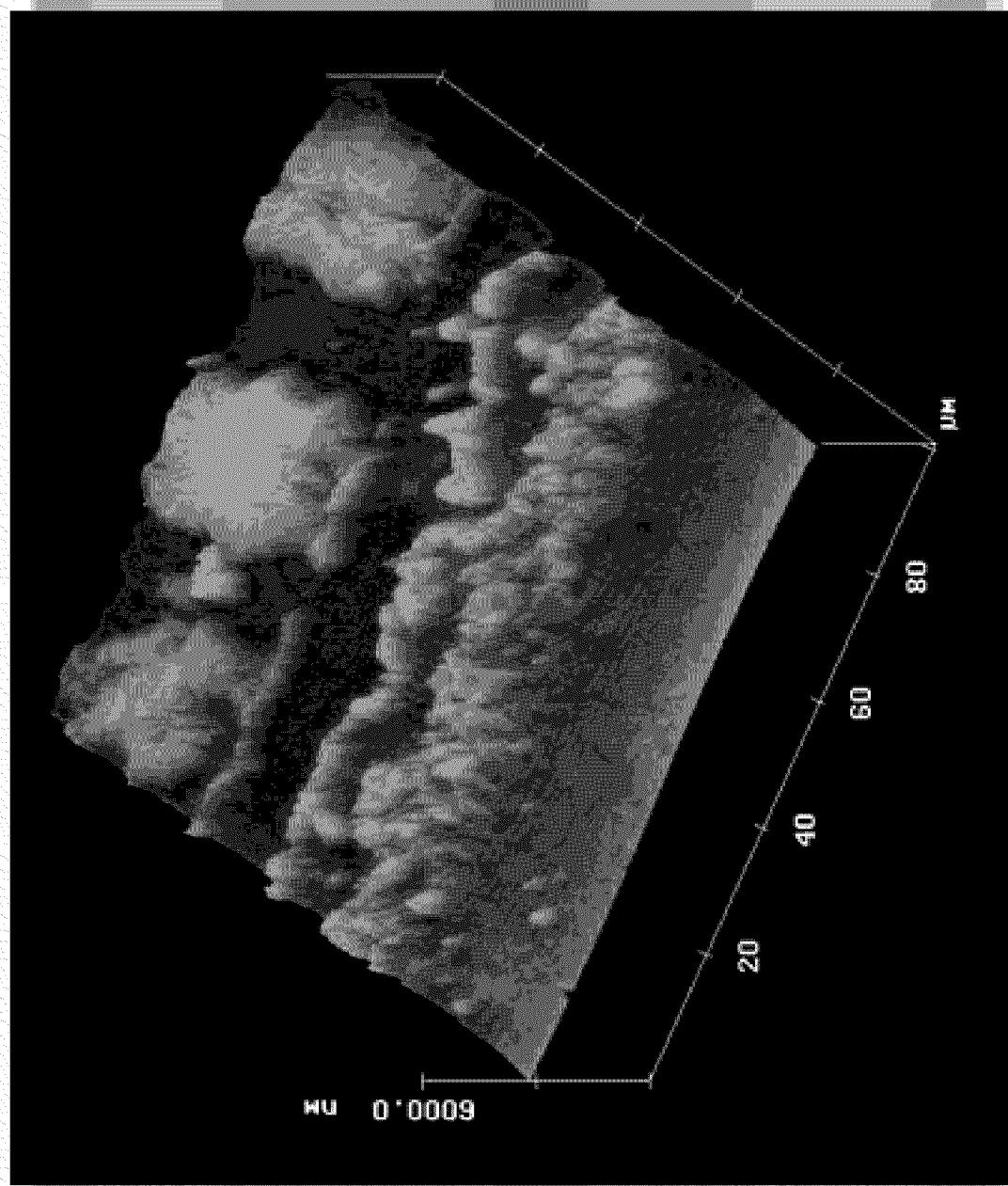
Coating Thermal Conductivity



Scanned-probe microscopy

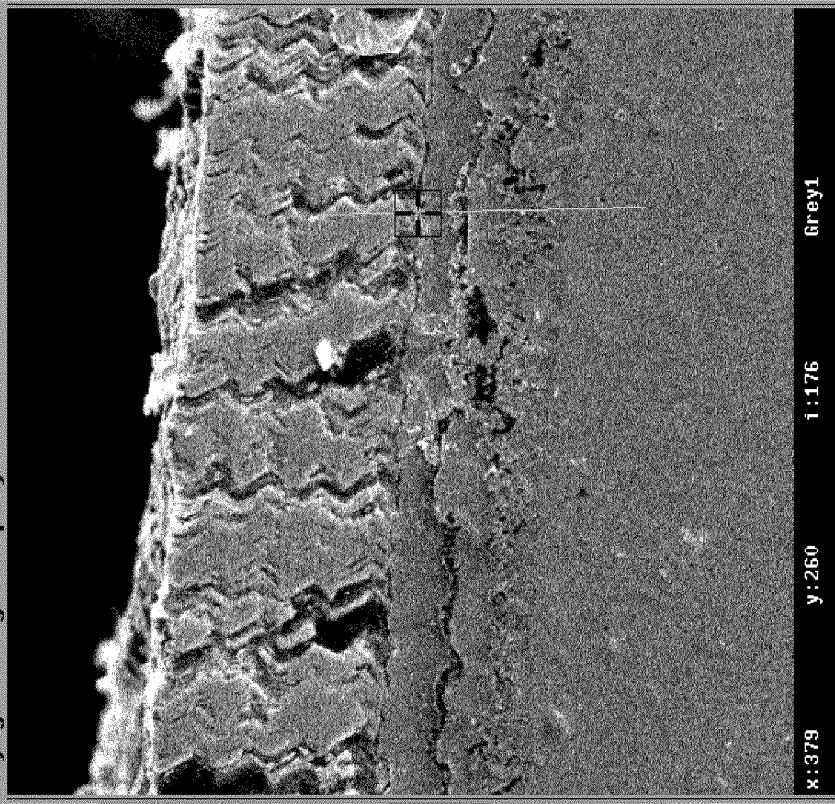


Polishing is an Issue

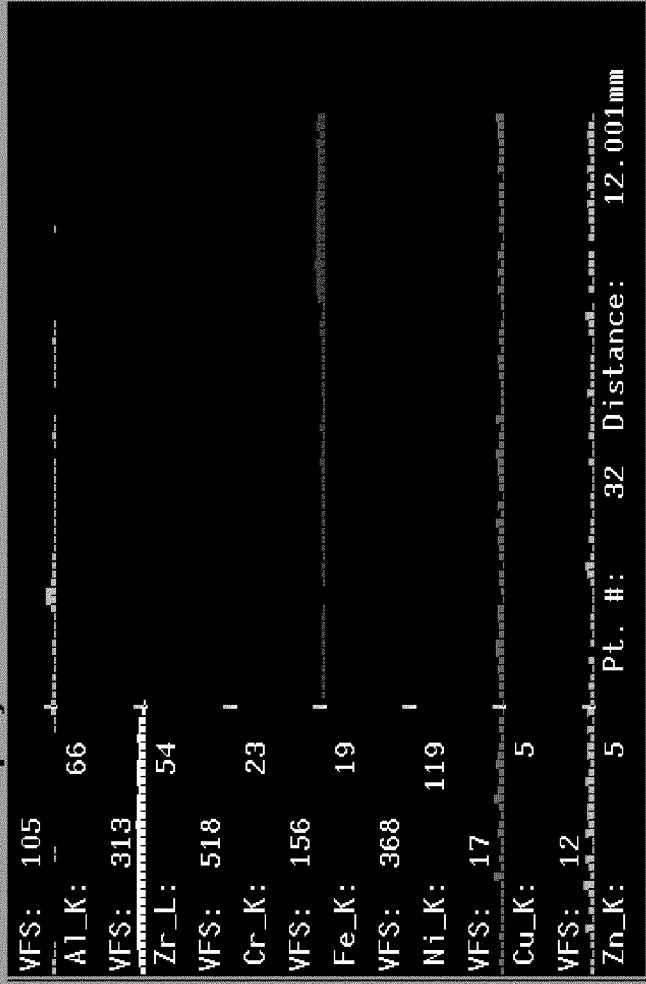


Analysis of the Layers

Voyager Image Display



Linescan Display



x:379 y:260 i:176 grey1

Thermal SPM

